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January 12, 1994

By Hand

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW
Washington, DC 20554

Re: Ex Parte Presentation
CC Docket No. 92-297
Local Multipoint Distribution Service

Dear Mr. Caton:

On behalf of Suite 12 Group ("Suite 12"), petitioner in the above-referenced rulemaking proceeding, enclosed please find two (2) copies of a technical study entitled "Satellite Earth Stations Operating in the 28 GHz Band Will Not Interfere with LMDS Receivers," which confirms that present and proposed satellite systems in the 28 GHz band will not interfere with the Local Multipoint Distribution Service ("LMDS").

Please place these two copies of this technical study in the above-referenced docket. Any questions regarding this study should be directed to the undersigned.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Charles R. Milkis
William J. Gildea III
Counsel for Suite 12 Group

Enclosures

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January 12, 1994

Dear Chairman Hundt
Commissioner Quello
Commissioner Barrett
Commissioner Duggan

By Hand

Re: "Satellite Earth Stations Operating in the 28 GHz Band Will Not Interfere with LMDS Receivers, CC Docket No. 92-297, LMDS

Suite 12 Group ("Suite 12") today filed the enclosed technical study, entitled "Satellite Earth Stations Operating in the 28 GHz Band Will Not Interfere with LMDS Receivers," which demonstrates that potential interference from Fixed Satellite Service ("FSS") earth station uplinks to Local Multipoint Distribution ("LMDS") LMDS receivers is virtually non-existent and inconsequential; moreover, as the study demonstrates, with the use of certain techniques the potential for interference can be reduced to zero. Thus, co-existence is readily feasible between LMDS and FSS in the 28 GHz band.

Suite 12's comprehensive study examines the potential interference to LMDS from NASA's ACTS system (representative of a GEO system), Motorola's Iridium system (representative of a LEO system) and Hughes' Spaceway system (representative of a proposed 28 GHz system), the primary classes of FSS systems operating or proposed to operate in the 28 GHz band. By confirming that FSS systems in the 28 GHz band will not interfere with LMDS receivers, this technical study unequivocally refutes the assertions of interference raised by NASA and other FSS interests who seek to preserve the valuable and grossly under-utilized 28 GHz spectrum for their possible use sometime in the future.

When this study is viewed in conjunction with three additional studies placed into the LMDS rulemaking record by Suite 12 (see "LMDS Does Not Interfere with NASA ACTS," filed 11/24/93, and "Supplemental Rebuttal," filed 1/6/94; and "LMDS Cannot Interfere with Motorola Iridium," filed 1/5/94), the record now confirms beyond any doubt that interference is not an issue for LMDS and FSS in the 28 GHz band. Moreover, co-existence between LMDS and FSS, as co-primary tenants of the 28 GHz band is possible, and clearly in the public interest.

Accordingly, in view of the ample record established in this proceeding supporting co-existence of LMDS and FSS in the 28 GHz band, and in view of the Commission's own findings expressed in its NPRM released early in 1993, we urge the Commission to adopt its previously proposed reallocation of the largely unused 28 GHz band for the pro-competitive LMDS, with the issuance of two 1 GHz licenses per service area. Please direct any questions to the undersigned.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Counsel for Suite 12 Group

Enclosure
cc Acting Secretary William F. Caton (for inclusion in the LMDS rulemaking record)

Satellite Earth Stations Operating in the 28 GHz Band Will Not Interfere with LMDS Receivers

by

• ***Bernard B. Bossard*** •

Suite 12 Inventor-Engineer

• ***Eric N. Barnhart. P.E.*** •

SATELLITE EARTH STATIONS OPERATING IN THE 28 GHz BAND WILL NOT INTERFERE WITH LMDS RECEIVERS

Introduction

The objective of this paper is to demonstrate that the LMDS system will not suffer from degraded performance due to the location of Satellite Earth Stations in the vicinity of the LMDS subscriber receivers. The methodology employed herein to address the potential interference issue is to draw upon references [1] and [2] as a basis for the NASA ACTS earth station uplink characteristics, reference [3] and [4] as a basis for Motorola IRIDIUM earth station uplink characteristics and reference [6] as a basis for Hughes Galaxy Spaceway earth station uplink characteristics. The paper then utilizes the parameters of the Suite 12 subscriber receiver and system geometry, and employs standard link budget and radio communications engineering principles to determine levels of interference and protection areas required between the ACTS earth stations and LMDS subscriber receivers, the IRIDIUM earth stations and LMDS subscriber receivers and the Spaceway earth stations and LMDS subscriber receivers.

For purposes of our analysis, by including the ACTS system, which is representative of a GEO system, the IRIDIUM system, which is representative of a LEO system, and the Spaceway system, which is representative of a proposed 28 GHz satellite system, we have encompassed the primary classes of current and prospective Fixed Satellite Service ("FSS") in the 28 GHz band. Thus, the following discussion, when specifically mentioning the ACTS program, should be viewed as encompassing all possible future FSS uses of the 28 GHz band by proposed GEO systems; similarly, when mentioning the proposed IRIDIUM program, the discussion should be viewed as encompassing all possible future FSS uses of the 28 GHz band by proposed LEO systems; finally, when referring to the proposed Spaceway program, the discussion should be viewed as encompassing any additional proposed future FSS use of the 28 GHz.

Consideration of Interference from GEO Systems to LMDS

In reference [1], page B-17 of Appendix B gives parameters for several classes of ACTS uplink emissions. Worst case for the emissions at 29.42 GHz with a 900 MHz bandwidth appears to be:

Total peak power:	+16 dBW
Isotropic Gain:	+60.7 dBi

This gives:

EIRP (on boresight)	+76.7 dBW

Another frequency assignment for earth station emission is 29.975 GHz, which falls outside the proposed LMDS band and is not considered since it will be filtered by the LMDS receiver or fall within its linear dynamic range with no degradation. Likewise, the ACTS beacon frequencies are outside the LMDS band.

Forbidden Zone near Earth Station due to Radiation Hazard

In the main beam of the earth station uplink antenna, sufficient power density is present to cause a radiation hazard as established by Equation 5 of the FCC/OST bulletin 65. This equation calculates the far field (Fraunhofer region) and the falloff of RF power density as:

$$S = (PG)/(4\pi R^2)$$

Where: S - power density

P = power fed to antenna

G = antenna gain

R = distance.

Then solving for R gives a range of 0.4 miles for the values:

$P = +16$ dBW

$G = +60.7$ dBi

$S = 5$ milliwatts/cm^2,

where 5 milliwatts/cm^2 is the ANSI radiation limit in the United States for human exposure for frequencies from 1 GHz to 100 GHz. It should be further noted that the International Non-Ionizing Radiation Committee (INIRC) radiation exposure is 5 milliwatts/cm^2 for occupational exposure and 1 milliwatt/cm^2 for general public exposure (from "Guidelines on Limit of Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range 100 kHz to 300 GHz, Health Physics, 54, 115; 1988). Hence, use of the 5 milliwatts/cm^2 value would appear to be conservative. Given that the protection range in the main beam is 0.4 miles, it is clear that the earth station uplink cannot be located at low elevations in urban areas. If this is true, then in such areas, which are typical deployment areas for LMDS, the ACTS earth stations must be located at fairly high elevations to satisfy line-of-sight requirements to the satellite and to eliminate radiation hazard risk. Thus, an ACTS antenna gain significantly below the main lobe gain of +60.7 dBi would be presented to any LMDS receiver. We approximate this gain, using both ACTS specifications and the FCC rules, in the next section.

ACTS Antenna Gain Toward the LMDS Receiver

The NASA ACTS earth station antenna elevation angle is a minimum of 30 degrees above horizon for any city in the continental United States. In the worst case, the LMDS receiver antenna is pointed at the horizon or skyward at an elevation angle of a few degrees. Thus it is obvious that in the worst case, the LMDS antenna mainbeam would be oriented toward the earth station site looking into a side lobe a minimum of 30 degrees from boresight of the ACTS antenna. In the more likely case, the LMDS antenna would present a side lobe to the earth station site, resulting in a 26 dB side lobe suppression due to the subscriber antenna. Furthermore, unless the LMDS receiver falls into the normal earth projection of the ACTS main lobe at a 30 degree elevation angle, the antenna gain from the ACTS antenna toward the LMDS receiver will be that associated with a side lobe greater than 30 degrees from the main lobe. Given this geometry, we note that by using Antenna Performance Standards as depicted in Section 25.209 of FCC Rules and Regulations, 47 C.F.R. § 25.209.

$$\text{Antenna Side Lobe Gain} = 32 - 25 \log(\theta)$$
$$= -5 \text{ dBi for } \theta = 30 \text{ degrees}$$

and

$$\text{Antenna Gain} = -10 \text{ dBi for } 48 \text{ degrees} < \theta < 180 \text{ degrees}$$

where

θ = angle from boresight.

We further note that reference [2], derived from NASA's specifications, gives a horizontal antenna gain of -8 dBi. Given these antenna characteristics, in the next section we compute the interference levels expected.

Interference Levels at LMDS Receiver

To calculate the interference level at the LMDS receiver as a result of emissions from the ACTS earth station, we consider two bounding cases:

Case 1: ACTS earth station co-located with the LMDS transmitter hub

Case 2: ACTS earth station located at the edge of an LMDS cell of 3 mile radius where the minimum LMDS signal occurs

Case 3: ACTS earth station located at ½ of the cell radius, or 1.5 miles from the LMDS transmitter

For Case 1:

In this case, the LMDS receiver antenna will always point toward the LMDS transmitter antenna and the ACTS earth station antenna since they are co-located. In addition, the range to the desired signal and undesired signal will be equal, so no range advantage accrues for either, and no LMDS receiver antenna discrimination occurs (in general). The carrier-to-inference ratio (C/I) where C is the desired LMDS signal and I is the ACTS signal, for any subscriber location in the cell, can be computed as follows:

EIRP for LMDS:	+ 7 dBW / channel (bandwidth = 18 MHz)
EIRP for ACTS:	+ 16 dBW total peak power
	- 8 dBi antenna gain toward LMDS receiver
	-17 dB or - 10 log (18 MHz/900 MHz)
	- 9 dBW / channel (bandwidth - 18 MHz)

Note that this gives a C/I of: 16 dB (i.e., +7 dBW -(-9 dBW)). Since the side lobes of the ACTS antenna are depolarized, we can assume that the polarization discrimination of the subscriber antenna reduces the interference power by an additional 3 dB, resulting in a C/I of 19 dB. Since the ACTS interference signal occupies the entire 18 MHz band and employs different modulation than LMDS (PSK versus FM), we treat the interference like noise and apply the 29 dB video transfer function to the C/I of 19 dB, resulting in a video S/N of 48 dB, producing a CCIR Q rating of greater than 4, which exceeds the cable standard. Note that this C/I can be further improved by consideration of the vast majority of cases where the earth station antenna gain is -10 dBi or less toward the LMDS receiver, and the height difference between the LMDS transmitter and ACTS earth station site produces an elevation angle difference. In these cases, the C/I would be greater than or equal to 21 dB, producing an S/N of at least 50 dB, yielding a CCIR picture Q rating which approaches 5, the best attainable.

<u>For Case 2</u>:

In this case, with the ACTS earth station site located at the edge of a 3-mile radius cell, it is clear that no subscriber receiver antenna would ever be oriented toward the ACTS earth station, since its antenna would be oriented toward the LMDS transmitter. Thus, the LMDS antenna would always present a side lobe to the ACTS earth station, providing discrimination of at least 26 dB. We now determine the approximate radius of a locus of points on the ground within which the C/I is unacceptable.

At the edge of the cell, the LMDS signal power gives:

C = -96.1 dBW / channel

C/N = 29.3 dB

Assuming that the ACTS transmitter presents an antenna gain of -10 dBi to the LMDS receiver:

ACTS EIRP = -11 dBW/ channel toward the LMDS receiver

Thus we can compute the protection radius around the ACTS site for various C/I by using the standard range equation:

P_r = -11 -36.6 - 20 log (f) - 20 log (d/5280) + GLMDS - 3 (in dB)

where:

P_r = ACTS power received at LMDS receiver input in dBW
f = frequency in MHz (28,000 MHz)
d = range in feet
GLMDS = gain of LMDS antenna in the direction of the ACTS transmitter

and the factor of minus 3 dB is for polarization discrimination in the LMDS antenna. Solving for "d", we get:

$d = 5{,}280 \times 10^{((Pr + 133.6) / (-20))}$, d in feet

for the case where GLMDS is +6 dBi, which is the peak LMDS antenna gain of +32 dBi reduced by the 26 dB side lobe discrimination.

Assuming we require a C/I of 16 dB to produce a video S/N of 45 dB and a picture quality of Q>3.8, then

P_r = -96.1 dBW/channel -16dB
= -112.1 dBW/channel,

and

$d = 444$ feet.

This means that, to maintain a picture quality (Q) of 3.8 or better, the LMDS receiver must be located at least 444 feet from the ACTS transmitter site. We must emphasize that this protection range is an upper bound which can be reduced by application of the true antenna pattern of the LMDS antenna (Attachment 1). To illustrate this, see Figure 1. The figure shows the 3-mile radius cell with the LMDS source at the center and the ACTS site at the edge of the cell. This is the geometry of "Case 2" defined above. Note that in Figure 1, we break the cell area into three regions for interference analysis; regions A, B and C. It can be demonstrated that the C/I for all three regions in which an LMDS receiver may be located exceeds the benchmark 16 dB for a Q of 3.8 or better.

Region A:

In this region, the LMDS receiver antenna is oriented such that its main lobe is presented to both the LMDS transmitter and the ACTS interference source. If this is true, then the 26 dB side lobe suppression against the ACTS is lost, and the protection range around ACTS must increase above the 444 feet value. Note that 26 dB is equivalent to range factor of 19.95:

$$20 \log (19.95) = 26 \text{ dB}.$$

Thus, the protection range must increase by a factor of 20 to maintain C/I of at least 16 dB. This gives a protection range of 20 times 444 feet, or 1.7 miles. Note that all points in region A in Figure 1 are a minimum of 3 miles from the ACTS site, so for all points in region A, the C/I meets or exceeds the 16 dB value. Thus, there is no interference to LMDS.

Region B:

In this region two conditions are satisfied for all LMDS receiver locations:

1) LMDS receiver antenna provides at least 26 dB side lobe suppression
2) LMDS receiver is at least 444 feet away from ACTS site by definition.

Therefore, for all points in region B of Figure 1, the C/I is 16 dB or better, yielding a Q of 3.8 or better.

Region C:

In this region, all possible subscriber locations are within 444 feet of the ACTS site by definition. At first glance, this would suggest that we would no longer be able to maintain a C/I of 16 dB or better. However, since for all points in region C, when the LMDS receiver antenna is on boresight to the LMDS transmitter, the angle from boresight to the ACTS site exceeds sixty (60) degrees. Therefore, the side lobe suppression of the receiver antenna is 37 dB, not 26 dB, as shown in Attachment 1. This gives a discrimination improvement of 11 dB, which is equivalent to a protection range reduction factor of 3.55:

$$20 \log (1/3.55) = -11 \text{ dB.}$$

Thus, the protection range of 444 feet can be reduced to 444/3.55 = 125 feet.

Taken together, all points in regions A, B and C (that is, all points at least 125 feet form the ACTS source) will produce a C/I of 16 dB and a Q of 3.8 or better. The locus of points in the LMDS cell within a radius of 125 feet from ACTS is labeled region D in Figure 1. It should be noted that this region is extremely small, and is roughly equivalent to a single subscriber location. This problem could be easily resolved by careful placement of the antenna.

For Case 3:

We take this case to be representative of any case whose geometry is such that the uplink antenna site is located in the cell at a location between the bounding cases of the cell center and cell edge (Cases 1 and 2, respectively, treated above). For Case 3, the uplink antenna is located in the cell at a radius of 1.5 miles from the cell center. With this geometry, there is not one, but two areas in the cell in which the LMDS subscriber antenna may present its main lobe to the satellite uplink antenna site. These are annotated Regions A and E in Figure 2. Other regions of interest for this geometry are labeled regions B, C and D in Figure 2. We now determine the radius of the locus of points around the satellite antenna site outside which the bench mark C/I of 16 dB is met or exceeded. This is done relative to the discussion for Case 2, above. We then address the interference characteristics for each of the areas in Figure 2.

At a range of 1.5 miles from the LMDS transmitter, the carrier power per channel of the LMDS system is

$$C = -90.1 \text{ dBW/channel}$$

Now, if we require a C/I of +16 dB, the interference power from the satellite uplink must not exceed

$$P_r = -90.1 \text{ dBW} - 16 \text{ dB} = -106.1 \text{ dBW}.$$

Substituting this into the equation for distance "d" derived in the discussion for Case 2 above gives:

$$d = 222 \text{ feet}.$$

This is not surprising, since we reduced the range to the LMDS transmitter site from the LMDS receiver by a factor of two (from 3 miles for Case 2 to 1.5 miles here), the range to the interfering satellite uplink antenna may also be reduced by a factor of two (from 444 feet for Case 2 to 222 feet here). Using this baseline value for the protection range, 222 feet, we now address specific regions of the cell as shown in Figure 2.

Region A:

In this region in Figure 2, the LMDS receiver antenna is oriented so that its main lobe is presented to both the LMDS transmitter and the uplink antenna site. If this is true, then the 26 dB side lobe suppression assumed in calculating the 222-foot protection range is lost. We earlier noted that 26 dB is equivalent to a range ratio of 19.95:

$$20 \log (19.95) = 26 \text{ dB}$$

Thus, the protection range must increase by a factor of 20 (19.95 rounded up) to maintain C/I of at least 16 dB. This gives a protection range of 20 times 222 feet, or 0.84 miles. Note that all points in Region A of Figure 2 are at least 1.5 miles from the interference source, so for all points in Region A, the C/I meets or exceeds the 16 dB value.

Region B:

In this region two conditions are satisfied for all LMDS receiver locations:

1) LMDS receiver antenna provides at least 26 dB side lobe suppression
2) LMDS receiver is at least 222 feet away from uplink antenna site by definition.

Therefore, for all points in Region B of Figure 2, the C/I is 16 dB or better.

Region C and Region D:

In Region C, all possible subscriber locations are within 222 feet of the uplink antenna site by definition. Thus, at first glance, this would suggest that LMDS would no longer be able to maintain the C/I of at least 16 dB. However, for many of the points inside the range of 222 feet from the satellite uplink antenna, when the LMDS receiver antenna is on boresight to the LMDS transmitter, the angle from boresight to the satellite uplink site exceeds sixty (60) degrees. Therefore, the side lobe suppression of the receiver antenna is 37 dB, not 26 dB, as shown in Attachment 1. This gives a discrimination improvement of 11 dB, which, as noted in the discussion for Case 2, allows a protection range reduction by a factor of 3.55. Thus, the protection range for much of Region C can be reduced to 222/3.55 = 63 feet. The interference area that remains is called Region "D" in Figure 2. It should be noted that the area of Region D can be associated with a maximum of one or two subscribers in a cell area of 28.3 square miles. This problem could be easily resolved by careful placement of the subscriber antenna.

Region E:

It was noted above that in addition to Region A, Region E includes subscriber locations such that the main lobe of the receiver antenna may point at both the LMDS transmitter and the satellite uplink antenna site. It can be shown that with this geometry, the points in Region E at the cell edge have C/I of 15 dB, which is 1 dB below the benchmark of 16 dB. Thus, in Region E, the C/I is not as high as desired. To address this problem, for all points in Region E, the subscriber receiver will employ a high gain (38 dBi peak, 2.2 degree beamwidth) antenna to achieve better discrimination (Reference [5]). Use of this antenna offers two advantages to minimize the size of Region E:

(1) First, the high-gain antenna is such that approximately 3 degrees off boresight, the side lobe suppression of 26 dB is available.

(2) Second, since the high-gain antenna offers 6 dB more gain than the standard antenna (38 dBi versus 32 dBi), the LMDS link can be operated with the subscriber antenna about 1.6 degrees off boresight, which is 6 dB down from peak gain. If this is done, an additional antenna discrimination of 17 dB (relative to the 6 dB point) is available to suppress points of interference an additional single degree off boresight of the LMDS receiver antenna (e.g., the interference signal from the satellite uplink antenna).

With both advantages the size of Region E, in which interference may remain, is only about 0.07 square miles, or only about 0.27 percent of the cell.

It should be noted that the 0.27 percent cell area for Region E approximates worst case. This can be seen as follows. Since we have a C/I of about 16 dB for the points in Region E at the cell edge, if the satellite uplink antenna was closer to the edge of the cell that is assumed for the Case 3 geometry, the area of Region E would be reduced since it is by definition between the uplink antenna site and the cell edge. Alternatively, if the satellite uplink antenna was closer to the center of the cell than assumed for the Case 3 geometry, the LMDS power available to points in Region E would be higher than for Case 3, and the size of Region E would be reduced. Thus, we can conclude that for situations in which the satellite uplink antenna is not at the center of the LMDS cell (Case 1), or at the edge of the cell (Case 2), but is somewhere in between, the maximum portion of the cell potentially affected by interference from the uplink is about 0.27 percent of the cell.

In any case, should interference persist in any LMDS subscriber locations for any reason, the number of LMDS subscribers suffering interference can be reduced to zero by employing any of the following techniques:

(1) Use of a repeater to allow the LMDS receiver antenna to point on boresight to the repeater but off boresight to the interference source, reducing the receiver antenna gain in the direction of the interference by 37 dB or more;

(2) Use of blockage from natural or man-made objects in the path to block the undesired interference signal. Even if blockage affects both signals, the interfering signal would arrive at the subscriber antenna with a different angle of arrival from the LMDS signal, allowing for discrimination against the interference by the receiver antenna;

(3) Use of frequency coordination—the uplink could be placed in one of the many nulls of the LMDS spectrum;

(4) Use of a special low-cost, low-power cell hub in the approximate center of the interference region;

(5) Use of special shrouding around satellite uplink or LMDS antennas.

These techniques would reduce the subscriber locations suffering from satellite uplink interference to zero.

Consideration of Interference from LEO Gateway Systems to LMDS

For completeness, since we have now considered the interference potential from ACTS, a GEO system, we consider the potential for interference from a LEO system. We will use Motorola IRIDIUM as an example. In reference [3], Appendix A, the following IRIDIUM parameters can be extracted:

HPA Output power:	-2.1 dBW
Antenna Gain (Peak):	+57.6 dBi
Transmit Circuit Loss:	3.5 dB

Therefore, the IRIDIUM uplink EIRP at boresight is:

$$-2.1 \text{ dBW} + 57.6 \text{ dBi} - 3.5 \text{ dB} = +52.0 \text{ dBW}.$$

Reference [3] further states that the bandwidth is 100 MHz and the carrier spacing is 15 MHz. We use this to approximate that there are six carriers in the 100 MHz bandwidth, and that one carrier will fall within a single LMDS channel bandwidth (18 MHz). Thus, the EIRP of 52.0 dBW must be scaled by:

$$10 \log (1/6) = 7.8 \text{ dB}$$

Also, the EIRP must be scaled to account for the antenna gain toward the horizon assuming the minimum 10-degree elevation angle for the earth station. We use the equation referenced a previous section for side lobe gain:

$$\text{Gain} = 32 - 25 \log (\theta), \text{ with } \theta = 10 \text{ degrees}.$$

This gives gain = +7 dBi. Then the EIRP must be adjusted as follows:

EIRP at horizon per LMDS channel =

$$52.0 \text{ dBW} - 7.8 \text{ dB} - (57.6 \text{ dBi} - 7 \text{ dBi}) = -6.4 \text{ dBW}.$$

Note that this value is:

$$-6.4 \text{ dBW} - (-11 \text{ dBW}) = 4.6 \text{ dB higher than the value for ACTS.}$$

Then we can note that the protection range around the IRIDIUM feeder uplink site must increase from 125 feet to 212 feet which is still insignificantly small. We further note in reference [4] that Motorola has proposed only two IRIDIUM feeder uplink sites in the entire continental U. S.

Consideration of Interference from Proposed 28 GHz Satellite Systems to LMDS

In order to be comprehensive, since we have now considered the interference potential from ACTS, a GEO system, and IRIDIUM, a LEO system, we consider the potential for interference from proposed 28 GHz satellite system uplinks. We are aware of two such systems:

(1) The Hughes Galaxy Spaceway VSAT System, described in Reference [6];
(2) COMSAT Project-21.

Discussions with COMSAT Project-21 development staff indicate that the specification for Project-21 uplinks is still under development and is not expected to be completed for at least several months from the date of this report. Thus, we will take the proposed Hughes Galaxy Spaceway system as representative of proposed 28 GHz satellite systems.

In reference [6], the following Hughes Spaceway system parameters can be found:

Transmit Power:	-3.0 dBW
Transmit Losses:	-0.5 dB
Antenna Gain (Peak):	+44.32 dBi

Therefore, the Spaceway uplink EIRP at boresight is:

$$-3.0 \text{ dBW} + -0.5 \text{ dB} + 44.32 \text{ dBi} = 40.8 \text{ dBW}.$$

Reference [5] further states that the bandwidth is 500 KHz, so the entire Spaceway uplink power will fall into the 18 MHz LMDS channel bandwidth, and no power scaling for relative bandwidth is required. However, the EIRP must be scaled to account for the antenna gain toward the horizon, assuming the typical case will place the LMDS receiver more than 48 degrees from boresight of the Spaceway uplink antenna. Then, using the previously cited FCC Rules and Regulations:

Spaceway antenna gain = -10 dBi.

Then, the EIRP must be adjusted as follows:

Spaceway EIRP at horizon per LMDS channel =

$$40.8 \text{ dBW} -(44.32 - (-10 \text{ dBi})) = -13.5 \text{ dBW}.$$

Note that this value is:

$$-11 \text{ dBW} - (-13.5 \text{ dBW}) = 2.5 \text{ dB lower than the value for ACTS.}$$

Then, we can note that the protection range around the Spaceway uplink antenna site can be decreased by a factor of 1.33 relative to that for ACTS since

$$20 \log (1.33) = 2.5 \text{ dB}.$$

The impact of this is as follows: The protection range around the Spaceway uplink antenna site can be decreased from 125 feet to 94 feet, which is even smaller than that for ACTS.

Summary

As shown above, this paper has established unequivocally that the LMDS system will not suffer from degraded performance due to the location of Satellite Earth Stations in the vicinity of the LMDS subscriber receivers. This has been demonstrated for the NASA ACTS system, which is representative of a GEO system in the 28 GHz band, for the Motorola IRIDIUM system, which is representative of a LEO system in the 28 GHz band, and for the Hughes Galaxy Spaceway system, which is representative of a proposed system in the 28 GHz band. For current, as well as future satellite systems of either type, the interference region, or equivalently the protection region, around the satellite transmitter is so small that it is inconsequential. Thus, the possibility of interference is virtually non-existent, and can be reduced to zero by using the techniques discussed in this paper. Thus, we can state without reservation that the LMDS system can coexist with Satellite Earth Stations operating in the 28 GHz band.

REFERENCES

[1] "Comments of the National Aeronautics and Space Administration," CC Docket No. 92-297, March 16, 1993

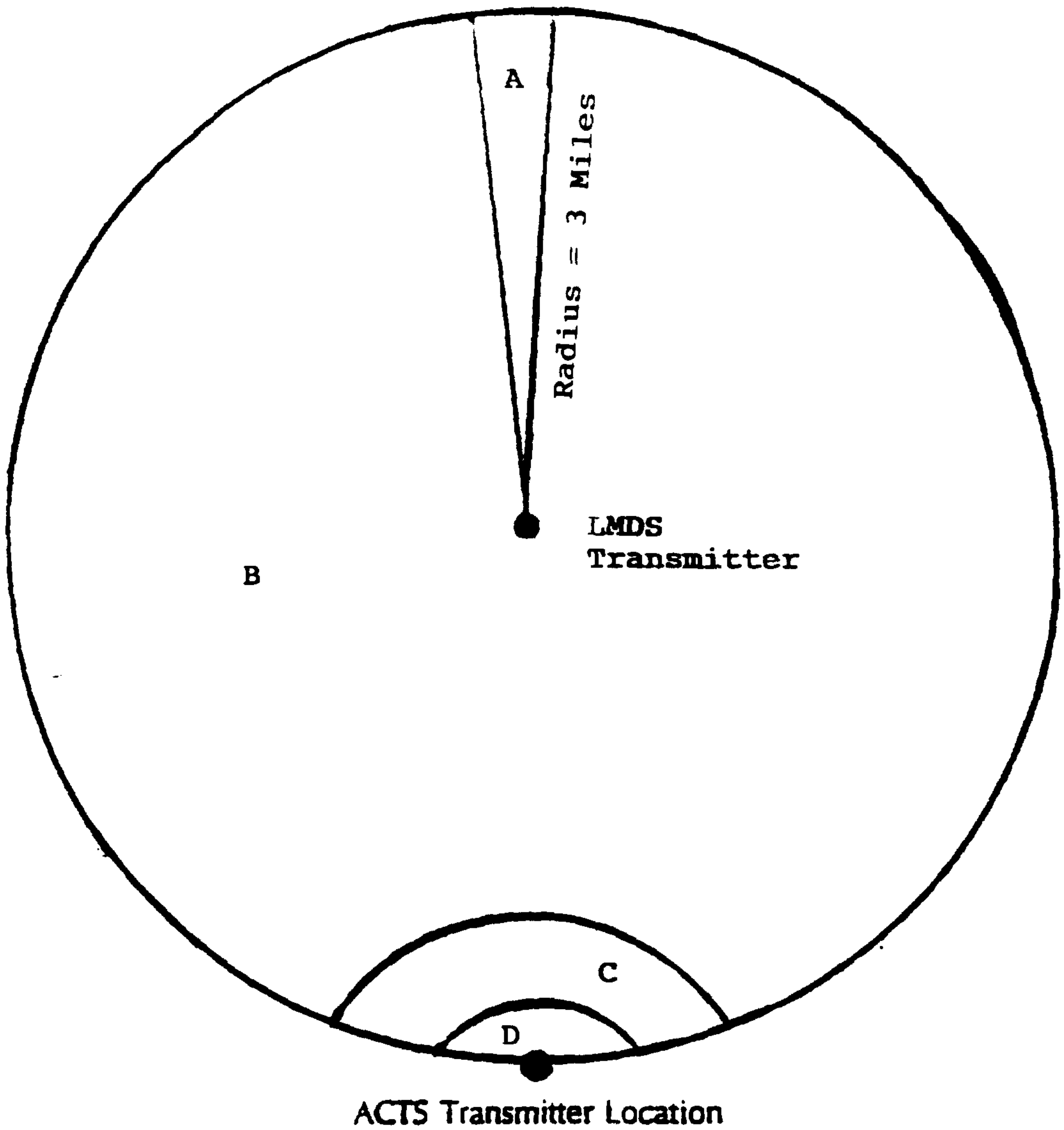
[2] Enclosure to Letter dated July 20, 1993, to Ms. Levitz, Acting Chief, CC Bureau, Re: CC Docket No. 92-297, from Richard D. Parlow, NTIA/Dept. of Commerce, "Technical Calculations"

[3] "Supplemental Information to IRIDIUM System Application," filed by Motorola Satellite Communications, Inc., File No. 9-DSS-P-911C87, February 22, 1991.

[4] "Comments of Motorola Satellite Communications, Inc.," CC Docket No. 92-297, March 16, 1993.

[5] "Suite 12 System Analysis for Video Distribution and Secondary Services," a report prepared by David Sarnoff Research Center, Princeton, NJ; September 17, 1991 for Suite 12, 12 Dag Hammarskjold Boulevard, Freehold, New Jersey 07728, Project Name: Brighton Beach, Task 2 Completion Report.

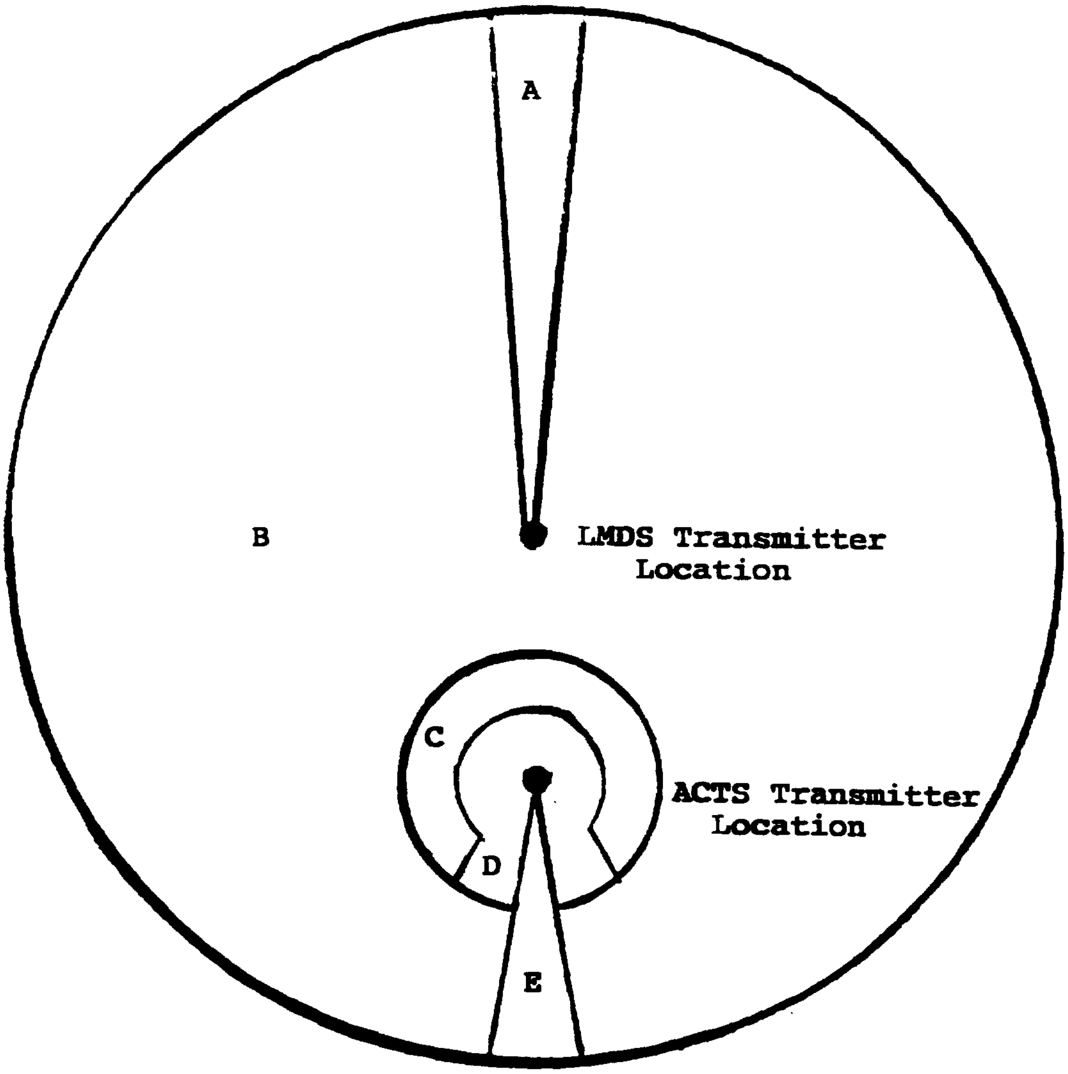
[6] Application of Hughes Communications Galaxy, Inc. for a two-satellite domestic fixed-communications satellite system to operate in the Ka band, dated December 3, 1993.



Region C: Radius of 444 feet from ACTS

Region D: Radius of 125 feet from ACTS

Figure 1. Case 2 Geometry



Region C: Radius of 222 feet from ACTS

Region D: Radius of 63 feet / 222 feet from ACTS

Figure 2. Case 3 Geometry

ATTACHMENT 1